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भाग 2 परीक्षण की पद्धति के चयन तथा सामान्य अपेक्षाओं की विषय विशिष्टि

Indian Standard

COMPLETE FILTER UNITS FOR RADIO INTERFERENCE SUPPRESSION

PART 2 SECTIONAL SPECIFICATION — SELECTION OF METHODS OF TEST AND GENERAL REQUIREMENTS

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BUREAU OF INDIAN STANDARDS
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NEW DELHI 110002

Febuary 1992 **Price Group 11**

Indian Standard

COMPLETE FILTER UNITS FOR RADIO INTERFERENCE SUPPRESSION

PART 2 SECTIONAL SPECIFICATION — SELECTION OF METHODS OF TEST AND GENERAL REQUIREMENTS

NATIONAL FOREWORD

This Indian Standard (Part 2) which is identical with IEC Pub 939-2 (1988) 'Complete filter units for radio interference suppression — Part 2 : Sectional specification — Selection of methods of test and general requirements', issued by the International Electrotechnical Commission (IEC), was adopted by the Bureau of Indian Standards on the recommendation of Electromagnetic Compatibility Sectional Committee and approval of the Electronics and Telecommunication Division Council.

The text of IEC Standard has been approved as suitable for publication as Indian Standard without deviations. Certain terminology and conventions are however not identical with those used in Indian Standards. Attention is especially drawn to the following:

a) Comma (,) has been used as decimal marker while in Indian Standards, the current practice is to use a point (.) as decimal marker.

b) Wherever the words 'International Standard' appear, referring to this standard, they should be read as `Indian Standard'.

c) For the purpose of this 'Indian Standard', only the metric dimensions are applicable.

CROSS REFERENCES

International Standard	*Indian Standard*	*Degree of Correspondence*
IEC Pub 60-1 (1973) High voltage test techniques — Part 1 : General definitions and test requirements	IS 2071 (Part 1) : 1974 Methods of high voltage testing : Part 1 General definitions and test requirements (*first revision*)	Technically equivalent
IEC Pub 85 Basic environmental testing procedures	IS 11182 Guide for the evaluation of insulation systems of electrical equipments	Technically equivalent
IEC Pub 384-1 (1982) Fixed capacitor for use in electronic equipment — Part 1 : Generic specification	ISQC 300000 : 1988 Fixed capacitors for use in electronics equipment. Generic specification	Identical
IEC Pub 939-1 (1988) Complete filter units for radio interference suppression — Part 1 : Generic specification	IS 13247 (Part 1) : 1992 Complete filter units for radio interference suppression : Part 1 Generic specification	Identical

The Electronics and Telecommunication Sectional Committee has reviewed the provisions of following IEC standard and has decided that it is acceptable for use in conjunction with this standard:

IEC Pub 279 (1969) Measurement of the winding resistance of an A.C. machine during operation at alternating voltage.

Only the English language text of the International Standard has been retained while adopting it in this Indian Standard.

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SECTION ONE - GENERAL

1 General

1.1 Scope

This standard is applicable to complete filter units for radio interference suppression which fall within the scope of the Generic Specification, IEC Publication 939-1.

1.2 Object

The object of this standard is to prescribe standard requirements for electrical shock hazard protection and to prescribe standard ratings and characteristics and to select from IEC Publication 939-1 the appropriate methods of test and to give general performance requirements for suppression filters. Test severities and performance requirements prescribed in detail specifications referring to this sectional specification shall be of equal or higher performance level because lower performance levels are not permitted. In addition the minimum requirements for electrical shock hazard protection specified herein always apply.

1.3 Related documents

IEC Publications:

Publication 60-1 (1973):	High-voltage Test Techniques Part 1: General Definitions and Test Requirements.
Publication 62 (1974):	Marking Codes for Resistors and Capacitors.
Publication 63 (1963):	Preferred Number Series for Capacitors and Resistors.
Publication 68:	Basic Environmental Testing Procedures.
Publication 85 (1984):	Thermal Evaluation and Classification of Electrical Insulation.
Publication 279 (1969):	Measurement of the Winding Resistance of an A.C. Machine During operation at Alternating Voltage.
Publication 384-1 (1982):	Fixed Capacitors for use in Electronic Equipment. Part 1: Generic Specification.
Publication 384-14 (1981):	Fixed Capacitors for use in Electronic Equipment. Part 14: Sectional Specification: Fixed Capacitors for Radio Interference Suppression. Selection of Methods of Test and General Requirements.
Publication 939-1 (1988):	Complete Filter Units for Radio Interference Suppression. Part 1: Generic Specification.

ISO Publication:

ISO 3 (1973):	Preferred Numbers - Series of Preferred Numbers.

1.4 Information to be given in a detail specification

Detail specifications shall be derived from the relevant blank detail specification.

Detail specifications shall not specify requirements inferior to those of the generic or sectional specification. When more severe requirements are included they shall be listed in Sub-clause 1.8 of the detail specification and indicated in the test schedules, for example by an asterisk.

Note. -The information given in Sub-clause 1.4.1 may for convenience, be presented in tabular form.

The following information shall be given in each detail specification and the values quoted shall preferably be selected from those given in the appropriate clause of this sectional specification.

1.4.1 Outline drawing and dimensions

There shall be an illustration of the filter as an aid to easy recognition and for comparison of the filter with others. Dimensions and their associated tolerances, which affect interchangeability and mounting, shall be indicated upon the drawing. All dimensions shall preferably be stated in millimetres, however when the original dimensions are given in inches, the converted metric dimensions in millimetres shall be added.

Normally the numerical values shall be given for the length of the body, the width and height of the body or for cylindrical types the body diameter, and the length and diameter of the terminations. When necessary, for example when a number of items (filter values/voltage ranges) are covered by a detail specification, the dimensions and their associated tolerances shall be placed in a table below the drawing.

When the configuration is other than described above, the detail specification shall describe this adequately.

1.4.2 Mounting

Filters shall be mounted by their normal means. When this is by axial wire terminations, the distance between the filter body and the mounting point on the terminations shall be 6 ± 1 mm. The design of the filter may be such that special mounting fixtures are required in its use. In this case, the detail specification shall describe the mounting fixtures and they shall be used in the application of the bump shock and vibration tests.

1.4.3 Ratings and characteristics

The ratings and characteristics shall be in accordance with the relevant clauses of this specification.

1.4.3.1 Particular characteristics

Additional characteristics may be listed when they are considered necessary to specify adequately the filter for design and application purposes.

1.4.4 Marking

Deviations from Sub-clause 1.6 of this sectional specification shall be specifically stated.

1.5 Terminology

See IEC Publication 939-1, Sub-clause 2.2.

1.6 Marking

1.6.1 The information given in the marking is normally selected from the following list; the relative importance of each item is indicated by its position in the list:

a) manufacturer/s name (or trade mark);
b) manufacturer/s type designation;
c) rated voltage;
d) rated current;
e) rated temperature;
f) climatic category;
g) year and month (or week) of manufacture (this may be in code form);
h) a circuit diagram of internal wiring showing all components, all capacitance values, their classes and inductance values;
i) reference to the detail specification.

1.6.2 The filter shall be clearly marked with a) and b) above and with as many as possible of the remaining items as is considered necessary. Any duplication of information in the marking on the filter should be avoided.

1.6.3 The package containing the filter(s) shall be clearly marked with all the information listed in Sub-clause 1.6.1.

1.6.4 Any additional marking shall be so applied that no confusion can arise.

SECTION TWO - PREFERRED RATINGS AND CHARACTERISTICS

2 Preferred ratings and characteristics

2.1 Preferred characteristics

The values given in detail specification shall preferably be selected from the following:

2.1.1 Preferred climatic categories

Radio interference suppression filters covered by this specification are classified into climatic categories according to the general rules given in IEC Publication 68-1.

The lower and upper category temperatures and the duration of the damp heat, steady state test shall be within the following ranges:

Lower category temperature: -55 °C, -40 °C, -25 °C and -10 °C.

Upper category temperature: +70 °C, +85 °C, +100 °C and +125 °C.

Rated temperature: not less than 40 °C.

Duration of the damp heat, steady state test: 10, 21 and 56 days.

The severities for the cold and dry heat tests are the lower and upper category temperatures respectively.

2.2 Preferred values of ratings

2.2.1 Rated capacitance and tolerances

Preferred values of rated capacitance are values chosen from the E6 series of preferred values given in IEC Publication 63: Preferred Number Series for Resistors and Capacitors. The maximum tolerance is ±20%, except for ceramic capacitors of Class X which may have a maximum tolerance of -20/+80%.

Note. -When the electrical shock hazard aspects of an equipment are considered in terms of leakage current, attention should be paid to the capacitance value and tolerance and, especially when ceramic capacitors with dielectric Class 2 are used, the temperature and voltage characteristic of the capacitance.

2.2.2 Rated inductance and tolerances

Rated inductance may either be specified as a minimum value or as a value with a tolerance.

The preferred values of rated inductance shall be selected from the E6 series of preferred values in IEC Publication 63. The preferred tolerances are:

±25%; -25/+50%; -25/+100%.

2.2.3 Rated resistance and tolerance

Preferred values of rated resistance are values chosen from the E6 and E12 series of preferred values given in IEC Publication 63: Preferred Number Series for Resistors and Capacitors. The tolerance shall be given in the detail specification.

2.2.4 Insertion loss

For filters which are designed for a particular equipment it shall not be required for the manufacturer to declare the insertion loss of the filter, since the performance of the filter is measured by its suppression effectiveness in the equipment. In other cases, however, where the manufacturer does declare the insertion loss of the filter he shall declare minimum insertion loss at specified frequencies, impedance and measuring method.

2.2.5 Rated voltage (U_R)

Preferred values for rated voltages are:

A.C. filters: 50, 125, 250, 380, 440 and 480 V.

D.C. filters: 50, 160, 250 and 500 V.

Note. -Radio interference suppression filters are normally chosen to have their rated voltage equal to or greater than the nominal voltage of the supply system to which they are to be connected. It should, however, be borne in mind that the voltage of the system may rise up to 10% above the nominal voltage.

2.2.6 Category voltage (U_C)

The category voltage is equal to the rated voltage unless otherwise stated in the detail specification.

2.2.7 Rated temperature

The rated temperature shall not be lower than +40 °C.

2.2.8 Rated current

The preferred values of rated current are selected from the R10 series of ISO 3.

SECTION THREE - QUALITY ASSESSMENT PROCEDURES

3 Quality assessment procedures

3.1 Primary Stage of Manufacture

The primary stage of manufacture of an interference suppression filter is the assembly of the piece-parts and the inductive, capacitive or resistive elements comprising the filter assembly.

The manufacturer may not sub-contract the primary stage of manufacture or any subsequent stage.

3.2 Structurally Similar Filters

Filters are structurally similar when for their range of component values they have the following common characteristics:

a) same capacitor technology;
b) same inductor technology;
c) same resistor technology;
d) similar design features and manufacturing techniques;
e) same rated voltage;
f) same current range.

3.3 Certified Records of Released Lots

(To be added later when Quality Conformance Inspection is added).

3.4 Qualification Approval

The procedure for Qualification Approval testing for structurally similar filters are given in Sub-clause 3.4 of the Generic Specification, IEC Publication 939-1.

3.4.1 Qualification Approval on the basis of the fixed sample size procedures

3.4.1.1 Sampling

This standard covers procedures for Qualification Approval tests only. Two alternative test procedures are given, namely the full test procedure covering both electrical shock hazard protection and performance requirements, and a restricted test procedure covering electrical shock hazard protection.

There are two sets of test schedules, one for filters made from qualified components, and one for other filters. If a filter is constructed from components qualified to IEC Publication 384-14 and/or IEC Publication 938-2, it may be tested according to the shorter test schedules in Table IA. If the components are not so qualified then the full test schedule in Table IB shall be used. Where electrical shock hazard protection tests only are required the test schedules in Tables IC or ID apply correspondingly.

Each rated voltage shall be separately qualified. The total number of filters of each rated voltage to be tested in each group is given in Tables IA, IB, IC or ID. For each rated voltage the sample shall contain approximately equal numbers of specimens of the highest and lowest rated current and the highest and lowest values of rated capacitance and rated inductance in the range to be qualified.

Spare specimens are permitted as follows:

(a) One per filter unit which may be used to replace the permitted defective in Group "0".

(b) One per filter unit which may be used as replacements for specimens lost due to incidents not attributable to the manufacturer or the test sequence.

(c) The remainder of the spares may be required if it is necessary to repeat any test according to the provisions of Note 1 to either Tables IA, IB, IC or ID.

(d) Spares may be kept at the premises of the manufacturer instead of being sent to the testing station.

The number of samples given in Group "0" assume that all groups are applicable. If this is not so the numbers may be reduced accordingly.

3.4.1.2 Tests

The complete series of tests specified in Tables IA, IB, IC or ID are required for the approval of a series of structurally similar filters of one rated voltage. The tests of each group shall be carried out in the order given.

The whole sample shall be subjected to the tests of Group 0 and then divided for the other groups.

Specimens found defective during the tests of Group 0 shall not be used for the other groups.

"One defective" is counted when a filter has not satisfied the whole or part of the tests of a group.

The approval is granted when the number of defectives does not exceed the number of permissible defectives specified in Tables IA, IB, IC or ID.

Note. -Tables IA, IB, IC or ID and II together form the fixed sample size test schedule, for which Tables IA, IB, IC or ID includes the details for the sampling and permissible defectives for the different tests or groups of tests, whereas Table II together with the details of test contained in Section Four gives a complete summary of test conditions and performance requirements and indicates where e.g. for the test method or conditions of test a choice has to be made in the detail specification.

The conditions of test and performance requirements for the fixed sample size test schedule shall be identical to those prescribed in the detail specification.

TABLE IA

Sampling plan

Electrical shock hazard protection and performance tests Filters constructed from separately qualified components

Group	Test	Sub-clause number of this publication	Number of specimens tested per rated voltage and for each mass group (5)	Number of permissible defectives per rated voltage and mass group (5)	
				Per group	Total
0	Dimensions Visual examination Continuity Voltage proof Insulation resistance	4.1 4.1 4.4 4.2 4.3	32/23/14/7	1	
	Spares		14/10/6/4		
1a	Robustness of terminations Resistance to soldering heat (2)	4.6 4.7	6/4/2/1	mains 0(1) other 1/1/0/0	2/1/1/1
1b	Solderability (2) Rapid change of temperature Vibration Bump or shock (4)	4.8 4.9 4.10 4.11 or 4.12	12/8/6/3	mains 0(1) other 1/1/0/0	
1	Climatic sequence	4.14	18/12/8/4	1/1/0/0	
2	Damp heat, steady state	4.15	10/8/4/2	mains 0(1) other 1/1/0/0	
5	Insertion loss (3)	4.5	4/3/2/1	1/1/0/0	

(1) If one defective is obtained, all tests of the group shall be repeated on a new sample and then no further defectives are permitted. The defective obtained in the first sample shall be counted for the total defectives permitted in the sixth column. Repetition of tests is permitted in one group only.
For filters other than mains filters, repetition of tests is not applicable, and the permitted defectives in a single sample shall be as stated.

(2) If applicable.

(3) If required in the detail specification.

(4) Whichever is required in the detail specification.

(5) The number of specimens indicated relate to the mass limits as follows:

$\leqslant 15$ g
> 15 g and $\leqslant 250$ g
> 250 g and $\leqslant 1500$ g
> 1500 g respectively.

TABLE IB

Sampling plan

Electrical shock hazard protection and performance tests Filters constructed from unqualified components

Group	Test	Sub-clause number of this publication	Number of specimens tested per rated voltage and for each mass group (5)	Number of permissible defectives per rated voltage and mass group (5)	
				Per group	Total
0	Dimensions	4.1			
	Visual examination	4.1			
	Continuity	4.4	58/42/22	1	
	Insertion loss	4.5			
	Voltage proof	4.2			
	Insulation resistance	4.3			
	Spares		14/10/6/4		
1a	Robustness of terminations	4.6	6/4/2/1	mains 0(1) other 1/1/0/0	2/1/1/1
	Resistance to soldering heat (2)	4.7			
1b	Solderability (2)	4.8	12/8/4/2	mains 0(1) other 1/1/0/0	
	Rapid change of temperature	4.9			
	Vibration	4.10			
	Bump or (4)	4.11 or			
	Shock	4.12			
1	Container sealing (3)	4.13			
	Climatic sequence	4.14	18/12/6/3	1/1/0/0	
2	Damp heat, steady state	4.15	10/8/4/2	mains 0(1) other 1/1/0/0	
3	Temperature rise (6)	4.16 or		mains 0(1) other 1/1/0/0	
	Endurance, current (7)	4.17.1	10/8/4/2		
	Endurance, Voltage, terminations/case	4.17.2	5/4/2/1		
	Endurance, Voltage between terminations	4.17.3	5/4/2/1		
4	Charge/discharge	4.18	6/4/2/1	0(1)	
5	Insertion loss (3)	4.5	4/3/2/1	1/1/0/0	

(1) If one defective is obtained, all tests of the group shall be repeated on a new sample and then no further defectives are permitted. The defective obtained in the first sample shall be counted for the total defectives permitted in the sixth column. Repetition of tests is permitted in one group only.
For filters other than mains filters, repetition of tests is not applicable, and the permitted defectives in a single sample shall be as stated.

(2) If applicable.
(3) If required in the detail specification.
(4) Whichever is required in the detail specification.
(5) The number of specimens indicated relate to the mass limits as follows:

≤ 15 g
> 15 g and ≤ 250 g
> 250 g and ≤ 1500 g
> 1500 g respectively.

(6) For filters with a mass >15 g only.
(7) For filters with a mass ≤15 g only.

TABLE IC

Sampling plan

Electrical shock hazard protection tests only
Filters constructed from separately qualified components

(applicable for mains filters only)

Group	Test	Sub-clause number of this publication	Number of specimens tested per rated voltage and for each mass group (3)	Number of permissible defectives per rated voltage and mass group (3)	
				Per group	Total
0	Dimensions	4.1		1	
	Visual examination	4.1			
	Continuity	4.4	16/12/6/3		
	Voltage proof	4.2			
	Insulation resistance	4.3			
	Spares		12/10/6/4		
1a	Robustness of terminations	4.6	6/4/2/1	0(1)	1/1/0/0
	Resistance to soldering heat (2)	4.7			
2	Damp heat, steady state	4.15	10/8/4/2	0(1)	

(1) For filters with a mass ≤ 250 g only:
If one defective is obtained, all tests of the group shall be repeated on a new sample and then no further defectives are permitted. The defective obtained in the first sample shall be counted for the total defectives permitted in the sixth column. Repetition of tests is permitted in one group only.
(2) If applicable.
(3) The number of specimens indicated relate to the mass limits as follows:

≤ 15 g
> 15 g and ≤ 250 g
> 250 g and ≤ 1500 g
> 1500 g respectively.

TABLE ID

Sampling plan

Electrical shock hazard protection tests only
Filters constructed from unqualified components

(applicable for mains filters only)

Group	Test	Sub-clause number of this publication	Number of specimens tested per rated voltage and for each mass group (3)	Number of permissible defectives per rated voltage and mass group (3)	
				Per group	Total
0	Dimensions	4.1	42/32/16/8	1	
	Visual examination	4.1			
	Continuity	4.2			
	Voltage proof	4.2			
	Insulation resistance	4.3			
	Spares		12/10/6/4		
1a	Robustness of terminations	4.6	6/4/2/1	0(1)	2/1/0/0
	Resistance to soldering heat (2)	4.7			
2	Damp heat, steady state	4.15	10/8/4/2	0(1)	
3	Temperature rise (4)	4.16 or	10/8/4/2	0(1)	
	Endurance, current (5)	4.17.1			
	Endurance, Voltage, terminations/case	4.17.2	5/4/2/1		
	Endurance, Voltage between terminations	4.17.3	5/4/2/1		
4	Charge/discharge	4.18	6/4/2/1	0(1)	

(1) For filters with a mass ≤ 250 g only:
If one defective is obtained, all tests of the group shall be repeated on a new sample and then no further defectives are permitted. The defective obtained in the first sample shall be counted for the total defectives permitted in the sixth column. Repetition of tests is permitted in one group only.

(2) If applicable.

(3) The number of specimens indicated relate to the mass limits as follows:
≤ 15 g
> 15 g and ≤ 250 g
> 250 g and ≤ 1500 g
> 1500 g respectively.

(4) For filters with a mass > 15 g only.

(5) For filters with a mass ≤ 15 g only.

TABLE II Test schedule

Notes 1. - Sub-clause numbers of test and performance requirements refer to Section Four: Test and measurement procedures.

2. - In this table: D = destructive, ND = non destructive.

Sub-clause number and Test (see Note 1)	D or ND	Conditions of test (see Note 1)	Number of specimens (n) and number of permissible defectives (pd)	Performance requirements (see Note 1)
Group 0	ND		See Tables IA to ID as applicable	
4.1 Dimensions				See detail specification
Visual examination				No visible damage
4.4 Continuity				No open circuit
4.5 Insertion loss		Not required for electrical shock hazard protection tests Asymmetric insertion loss without load at 2 frequencies, one near each end of operating range		See detail specification
4.2 Voltage proof		See Table III and detail specification for the method		No permanent breakdown or flashover
4.3 Insulation resistance		See detail specification for the method		As in 4.3
Group 1A	D		See Tables IA to ID as applicable	
4.6 Robustness of terminations				
4.7 Resistance to soldering heat (if applicable)		See detail specification for the method (1A or 1B) For Method 1A: immersion time: 10s unless otherwise specified in the detail specification		
4.7.2 Final measurements		Visual examination		No visible damage
		Continuity		No open circuit
		Insertion loss (not required for electrical shock hazard protection tests)		As in 4.5

Sub-clause number and Test (see Note 1)	D or ND	Conditions of test (see Note 1)	Number of specimens (n) and number of permissible defectives (pd)	Performance requirements (see Note 1)
Group 1B	D		See Tables IA to ID as applicable	
4.8 Solderability (if applicable)		See detail specification for the method		Good tinning as evidenced by free flowing of the solder with wetting of the terminations, or solder shall flow within 3 s, as applicable
4.9 Rapid change of temperature		Visual examination		No visible damage
4.10 Vibration		For mounting method see detail specification Procedure B4 Frequency range: from ... to ... Hz Amplitude: 0.75 mm or acceleration 98 m/s^2 (whichever is the less severe) Total duration: 6 h		
		Visual examination		No visible damage
4.11 Bump (or shock, see 4.12)		For mounting method see detail specification Number of bumps: ... Acceleration: ... m/s^2 Duration of pulse: ... ms		
		Visual examination		No visible damage
4.12 Shock (or bump, see 4.11)		For mounting method see detail specification Acceleration: ... m/s^2 Duration of pulse: ... ms		
4.12.2 Final measurements		Visual examination		No visible damage
		Continuity		As in 4.4
		Insertion loss (not required for electrical shock hazard protection tests)		As in 4.5

Sub-clause number and Test (see Note 1)	D or ND	Conditions of test (see Note 1)	Number of specimens (n) and number of permissible defectives (pd)	Performance requirements (see Note 1)
Group 1	D		See Tables IA to ID as applicable	
4.13 Container sealing (if required in the detail specification)		Test Q		No leakage
4.14 Climatic sequence				
4.14.2 Dry heat		Temperature: upper category temperature Duration: Mass ≤ 250 g: 2 h > 250 g: 16 h		
4.14.3 Damp heat, cyclic, Test Db, first cycle				
4.14.4 Cold		Temperature: lower category temperature Duration: 2 h		
4.14.5 Low air pressure (if required in the detail specification		Air pressure 8.5 kPa (85 mbar) unless otherwise stated in detail specification		No permanent breakdown, flashover, or harmful deformation of the case or seepage of impregnant
4.14.6 Damp heat, cyclic, Test Db, remaining cycles				
4.14.7 Final measurements		Visual examination		No visible damage Legible marking
		Continuity		As in 4.4
		Insertion loss as Group 0		As in 4.5
		Voltage proof Voltage: 66% of voltage applied in Group 0		No permanent breakdown or flashover
		Insulation resistance		≥ 50% of values in 4.3

Sub-clause number and Test (see Note 1)	D or ND	Conditions of test (see Note 1)	Number of specimens (n) and number of permissible defectives (pd)	Performance requirements (see Note 1)
Group 2	D		See Tables IA to ID as applicable	
4.15 Damp heat, steady state				
4.15.1 Final measurements		Visual examination		No visible damage Legible marking
		Continuity		As in 4.4
		Insertion loss as Group 0 (not required for electrical shock hazard protection tests)		As in 4.5
		Voltage proof Voltage: 66% of voltage applied in Group 0. A polarizing voltage shall be applied if specified in the detail specification		No permanent breakdown or flashover
		Insulation resistance		≥50% of values in 4.3
Group 3	D		See Tables IA to ID as applicable	
4.16 Temperature-rise, (if applicable)		Duration: until thermal equilibrum has been reached		
4.16.1 Test conditions		Current: rated current Ambiant temperature: rated temperature		
4.16.2 Final measurements		Final temperature of the hot spot defined		To meet the temperature requirements of the group of insulation materials used for the inductors tested and of the capacitors incorporated
		Visual examination		No visible damage Legible marking
4.17.1 Endurance, current test (if applicable)		Duration: 1 000 h Current: rated current		

Sub-clause number and Test (see Note 1)	D or ND	Conditions of test (see Note 1)	Number of specimens (n) and number of permissible defectives (pd)	Performance requirements (see Note 1)
4.17.2 Endurance, Voltage, termination/ case		Duration: 1 000 h Voltage: 1.7 times rated voltage	↓	
4.17.3 Endurance, Voltage between terminations		Duration: 1 000 h Voltage: 1.25 times rated voltage		
4.17.4 Final measurements		Visual examination		No visible damage Legible marking
		Continuity		As in 4.4
		Insertion loss as Group 0 (not required for electrical shock hazard protection tests)		As in 4.5
		Voltage proof: 66% of voltage applied in Group 0		No permanent breakdown or flashover
		Insulation resistance	↓	>50% of values in 4.3
Group 4 4.18 Charge and discharge	D	Only if metallized film or metallized paper capacitors are used in the filter	See Tables IA to ID as applicable ↓	As in 4.18.3
Group 5 4.5 Insertion loss (if required in the detail specification)	ND	The detail specification shall specify the test methods	See Tables IA to ID as applicable ↓	The detail specification shall specify requirements

3.5 Quality Conformance Inspection

(To be completed later).

SECTION FOUR - TEST AND MEASUREMENT PROCEDURES

This section supplements the information given in IEC Publication 939-1, Section Four.

4 Test and measurement procedures

4.1 Visual examination and check of dimensions

See IEC Publication 939-1, Sub-clause 4.4.

4.2 Voltage proof

Sub-clause 4.6 of IEC Publication 939-1 with the following details:

(a) The test voltage to be applied to mains filters is given in Table III below. For other filters the test voltage shall be specified in the detail specification.

TABLE III

Measuring points

Filters for	Test A between terminations	Test B or C internal or external insulation
Alternating current $U_R \leqslant 125$ V	4.3 U_R (d.c.) (1)	900 V (a.c.)
Alternating current $U_R > 125$ V	4.3 U_R (d.c.)	2 U_R + 1 500 V (a.c.) with a minimum of 2 000 V (a.c.)
Direct current $U_R \leqslant 125$ V	3 U_R (d.c.) (1)	2 U_R + 1 500 V (d.c.)
Direct current $U_R > 125$ V	3 U_R (d.c.)	2 U_R + 1 500 V (d.c.)

(1) Not applicable for filters of rated voltage less than 50 V.

Note. -If the filter contains U or Y capacitors connected between terminations and case or between terminations and earth termination then, instead of the voltage for tests B or C, the appropriate U or Y voltage given in Table V Test A of IEC Publication 384-14 shall be used.

For explanation of Tests A, B or C see IEC Publication 939-1, Table III.

(b) The method of applying the test voltage for Test C may be any of the methods specified in IEC Publication 939-1, Sub-clause 4.6.2.3. In case of doubt the foil method is to be used.

(c) For Qualification approval tests the full test voltage shall be applied for 1 min.

(d) For d.c. tests the charge and discharge current shall not exceed 0.05 A.

(e) For d.c. tests the time constant $R_1.C_x$ shall not exceed 1s, where C_x is the total capacitance across the terminals to which the test voltage is applied.

(f) For qualification approval a.c. tests the voltage shall be supplied from a transformer. The voltage shall be raised from near zero to the test voltage at a rate not faster than 150 V/s. The test time shall begin at the moment the test voltage is reached. For quality conformance tests the detail specification may require the full test voltage to be applied directly.

Notes 1. -Attention is drawn to the fact that repetition of the voltage proof test may damage the filter.

2. -Attention is drawn to the fact that for some tests it may be necessary for the detail specification to prescribe that resistors or varistors should be disconnected.

4.3 Insulation resistance

Sub-clause 4.5 of IEC Publication 939-1 with the following details:

(a) The measuring voltage shall be as prescribed in IEC Publication 939-1, Sub-clause 4.5.2.

(b) The method of applying the test voltage for Test C may be any of the methods specified in IEC Publication 939-1, Sub-clauses 4.5.2.1, 4.5.2.2 and 4.5.2.3. In case of doubt the foil method of Sub-clause 4.5.2.1 is to be used.

(c) The minimum value of insulation resistance shall neither be less than specified in Tabel IV for filters with a single capacitor nor less than this value divided by the number of capacitors connected in parallel for filters employing more than one capacitor.

TABLE IV

Climatic category	Test A		Tests B or C
	when $C > 0.33$ µF RC in seconds	when $C \leqslant 0.33$ µF R in MΩ	R in MΩ
-/-/56	4 000	12 000	12 000
-/-/21 and -/-/10	2 000	6 000	6 000

Note. -If the filter contains U or Y capacitors connected between terminations and case, the appropriate limit for U or Y capacitors from Table VI of IEC Publication 384-14 shall be used instead of the limit for Tests B or C.

Continuity

Using a d.c. ohmmeter with an applied voltage of less than 10 V, the electrical continuity shall be checked between all pairs of terminals where the circuit diagram indicates there should be continuity. No open circuit shall be found.

4.5 Insertion loss

Sub-clause 4.7 of IEC Publication 939-1 with the following details:

The detail specification shall specify the method to be used, the load current if any and the terminating impedances.
After conditioning, where the initial value was $\leqslant 100$ dB, the measured value shall be within ± 6 dB of the initial value; and where the initial value was > 100 dB the measured value shall be > 94 dB unless tighter limits are specified in the detail specification.

4.6 Robustness of terminations

See IEC Publication 939-1, Sub-clause 4.8.

4.7 Resistance to soldering heat

Sub-clause 4.9 of IEC Publication 939-1 with the following details:

Not applicable to filters with insulated leads with insulation length greater 10 mm or with snap-on terminations.

4.7.1 Conditions

No pre-drying.

4.7.2 Final inspection, measurements and requirements

The filters shall be visually examined and measured and shall meet the requirements given in Table II.

4.8 Solderability

Sub-clause 4.10 of IEC Publication 939-1 with the following details:

4.8.1 When the solder globule method is used the soldering time shall be less than 3 s.

4.8.2 The requirements are given in Table II.

4.9 Rapid change of temperature

Sub-clause 4.11 of IEC Publication 939-1 with the following details:

4.9.1 Number of cycles: 5.
Duration of exposure at the temperature limits: 30 min for mass $\leqslant 250$ g
3 h for mass > 250 g

4.10 Vibration

Sub-clause 4.12 of IEC Publication 939-1 with the following details:

4.10.1 Procedure B4 and one of the following severities of test Fc, as specified in the detail specification.

Displacement or acceleration, whichever is the lower acceleration, as specified in the table

Mass group	Amplitude or acceleration (whichever is the lower acceleration)
> 50 g	0.35 mm or 49 m/s^2 (5 g)
$\leqslant 50$ g	0.75 mm or 98 m/s^2 (10 g)

over one of the following frequency ranges: 10 Hz to 55 Hz, 10 Hz to 500 Hz, 10 Hz to 2 000 Hz. The total duration shall be 3 x 2 h.

The detail specification shall specify the frequency range and shall also prescribe the mounting method to be used.

4.10.2 Final inspection and requirements

The filters shall be visually examined and shall meet the requirements in Table II.

4.11 Bump

Sub-clause 4.13 of IEC Publication 939-1 with the following details:

4.11.1 The detail specification shall state whether the bump or the shock test applies.

The detail specification shall state which of the following severities applies:

Total number of bumps:	1 000 or 4 000		
Acceleration:	390 m/s^2(40 g)	or	98 m/s^2(10 g)
Pulse duration:	6 ms		16 ms

The detail specification shall also prescribe the mounting method to be used.

4.11.2 Final inspection and requirements

The filters shall be visually examined and shall meet the requirements given in Table II.

4.12 Shock

Sub-clause 4.14 of IEC Publication 939-1 with the following details: The detail specification shall state whether the bump or the shock test applies.

4.12.1 The detail specification shall state which of the following preferred severities applies:
Pulse shape: half-sine

Peak acceleration (m/s^2 (g))	Corresponding duration of the pulse (ms)
294 (30)	18
490 (50)	11
981 (100)	6

The detail specification shall also prescribe the mounting method to be used.

4.12.2 Final inspection, measurements and requirements

The filters shall be visually examined and measured and shall meet the requirements in Table II.

4.13 Container sealing

See IEC Publication 939-1, Sub-clause 4.15.

4.14 Climatic sequence

Sub-clause 4.16 of IEC Publication 939-1 with the following details:

4.14.1 Initial measurements

Not required.

4.14.2 Dry heat

No measurements are required at the upper category temperature.

4.14.3 Damp heat, cyclic, Test Db, first cycle

See IEC Publication 939-1, Sub-clause 4.16.3.

4.14.4 Cold

No measurements are required at the lower category temperature.

4.14.5 Low air pressure

Sub-clause 4.16.5 of IEC Publication 939-1 with the following details:

If required in the detail specification, the test shall be made at a temperature of 15 °C to 35 °C and a pressure of 8.5 kPa (85 mbar), unless otherwise stated in the detail specification. The duration of the tests shall be 1 h.

During and after the test there shall be no evidence of permanent breakdown, flashover, or harmful deformation of the case.

4.14.6 Damp heat, cyclic, Test Db, remaining cycles

See IEC Publication 939-1, Sub-clause 4.16.6.

4.14.7 Final inspection, measurements and requirements

After recovery, the filters shall be visually examined and measured and shall meet the requirements given in Table II.

4.15 Damp heat, steady state

Sub-clause 4.17 of IEC Publication 939-1 with the following details:

4.15.1 Final inspection, measurements and requirements

After recovery, the filters shall be visually examined and measured and shall meet the requirements in Table II.

4.16 Temperature rise (Applies only to filters with a mass > 15 g)

See IEC Publication 939-1, Sub-clause 4.18 with the following details:

4.16.1 Test conditions

The rated a.c. current or d.c. current equal to the r.m.s. value of the rated a.c. current shall be applied.

4.16.2 Final measurements

After thermal equilibrium has been reached the temperature of the filter element(s) shall be defined by evaluating the change of resistance of the winding of the inductor of the filter.

The temperature of a winding (θ_2) at the end of a test period shall be calculated from its measured resistance (R_2) at the temperature θ_2 and its measured resistance (R_1) at some other temperature (θ_1) using the formula:

$$\theta_2 = \frac{R_2}{R_1} (235 + \theta_1) - 235 \text{ for copper}$$

$$\theta_2 = \frac{R_2}{R_1} (225 + \theta_1) - 225 \text{ for aluminium}$$

where θ_1 and θ_2 are expressed in degrees Celcius.

The resistance (R_1) is generally the cold resistance measured at the beginning of the test. The resistance (R_2) is measured either after switching off the supply, or without interruption of the supply by means of the superposition method, which consists of injecting into the winding a d.c. measuring current of low value superposed on the load current. (The use of superposed d.c current for the measurement of the resistances of a.c. machines is described in IEC Publication 279).

This test has to verify whether the temperature of the hot spot of the filter under rated working conditions meets the temperature requirements of the group of insulating materials used for the inductor according IEC Publication 85 and the capacitors incorporated.

The class of insulating materials used according to IEC Publication 85 shall be stated in the detail specification or given with the complete marking information of the filter.

The requirements of Table II shall be met.

4.17 Endurance (Applies only to filters with a mass ≤ 15 g)

See IEC Publication 939-1, Sub-clause 4.19 with the following details:

4.17.1 Test conditions-current test

After the chamber has been stabilised at the rated temperature, the rated current shall be passed through the filters. The maximum case temperature of one of the filters shall be measured after equilibrium has been reached, and shall not exceed the upper category temperature.

After 1 000 h the filters shall be allowed to cool to room temperature, and shall then meet the requirements of Sub-clause 4.6.4.

Note. -A fuse or other device of suitable sensitivity may be connected in the filter supply circuit to indicate if failure occurs.

4.17.2 Test conditions - voltage test, terminations/case

The filters shall be submitted to an endurance test of 1 000 h at the upper category temperature at a voltage of 1.7 U_R, which shall be connected between the windings connected together and the case and earth terminal connected together. For a.c. rated filters once in every hour the voltage shall be increased to 1 000 V r.m.s. for 0.1 s. This higher voltage shall be applied through a resistor of 220 Ω ± 10%.

For d.c. filters the voltage shall be applied through a resistor whose value is approximately 1 Ω per applied volt.

The test circuit should be designed so that voltage peaks are avoided.

The filters shall then be allowed to cool to room temperature and shall meet the requirements of Sub-clause 4.17.4.

4.17.3 Test conditions - voltage test between terminations

For filters with multi-section capacitors, all the X-capacitor-sections shall be tested in parallel, if necessary by shorting out any U or Y-sections.

Filters containing capacitors of Class X1 shall, prior to the endurance test, be submitted to a pulse test with a 1.2/50 µs full wave according to IEC Publication 60 (an example of a suitable test circuit is given in Appendix C). The shape of the pulse shall be adjusted by means of resistor R_e with the capacitor under test connected. When capacitors with selfhealing properties are to be tested, R_e shall be adjusted using a capacitor without self-healing properties having the same capacitance value as the capacitor under test. Three pulses, approximately one per second, with a peak voltage of Up shall be applied:

For $C \leqslant 0.33$ µF $U_p = 4$
For $C > 0.33$ µF $U_p = 4e^{(0.33 - C)}$

where Up is in kV and C in µF.

The filters shall then be submitted to an endurance test of 1 000 h at upper category temperature at a voltage of 1.25 U_R, which shall be connected between the line terminals, or in the case of a single-phase filter between line and neutral. For a.c. rated filters once in every hour the voltage shall be increased to 1 000 V r.m.s. for 0.1 s. This higher voltage shall be applied through a resistor of 220 Ω ± 10%. A suitable circuit is shown in Appendix A.

For d.c. filters the voltage shall be applied through a resistor whose value is approximately 1 Ω per applied volt.

The test circuit should be so designed that voltage peaks are avoided.

The filters shall then be allowed to cool to room temperature and shall meet the requirements of Sub-clause 4.17.4.

4.17.4 Final inspection, measurements and requirements

After recovery, the filters shall be visually examined and measured and shall meet the requirements of Table II.

4.18 Charge and discharge

This test applies only to filters which contain metallized film or metallized paper capacitors as Class X capacitors connected between line terminations or between line and neutral terminations.

The corresponding input and output terminations of the filter shall be connected together, thus shorting out any internal inductors. The filter shall then be tested as a capacitor as follows:

4.18.1 Initial measurements

The capacitance shall be measured in accordance with Sub-clause 11.2 of IEC Publication 384-14.

The tangent of loss angle shall be measured according to Clause 4.8 of IEC Publication 384-1 with the following details:

Capacitance:	$\leqslant 1$ µF	Capacitance:	> 1 µF
Frequency:	10 kHz	Frequency:	1 kHz
Voltage:	1 V r.m.s. max.	Peak voltage:	$\leqslant 3\%$ of rated voltage
Inaccuracy:	$\leqslant 0.001$ (absolute value)	Inaccuracy:	$\leqslant 0.001$ (absolute value)

4.18.2 The capacitors shall be subjected to 10 000 cycles of charge and discharge at the rate of approximately one operation per second.

Each cycle shall consist of charging and discharging the capacitor.

For a.c. rated capacitors the test voltage shall be $\sqrt{2}\,.U_R$ and for d.c. rated capacitors the test voltage shall be U_R.

Each capacitor shall be individually discharged through a resistor of such a value that the maximum voltage gradient shall be 100 V/µs.

A suitable circuit is given in Appendix B.

4.18.3 Final measurements and requirements

The capacitors shall be measured and shall meet the requirements in Table V.

TABLE V

Measurement	Measuring method	Requirements
Capacitance	IEC Publication 384-14, Sub-clause 11.2	The difference between the capacitance measured finally and in Sub-clause 4.18.1 shall not exceed 10%
tan δ for $C \leqslant 1$ µF $f = 10$ kHz	Sub-clause 4.18.1	The increase of tan δ with respect to tan δ measured in Sub-clause 4.18.1 shall not exceed 80.10^{-4}
tan δ for $C > 1$ µF $f = 1$ kHz	Sub-clause 4.18.1	The increase of tan δ with respect to tan δ measured in Sub-clause 4.18.1 shall not exceed 50.10^{-4}
Insulation resistance	Sub-clause 4.3	Insulation resistance shall be minimum 50% of the applicable values of Table IV of Sub-clause 4.3.

Appendix A

Example of a circuit for the voltage endurance tests for a.c. filters

The tests described in Sub-clauses 4.17.2 and 4.17.3 may be carried out with one of the following circuits:

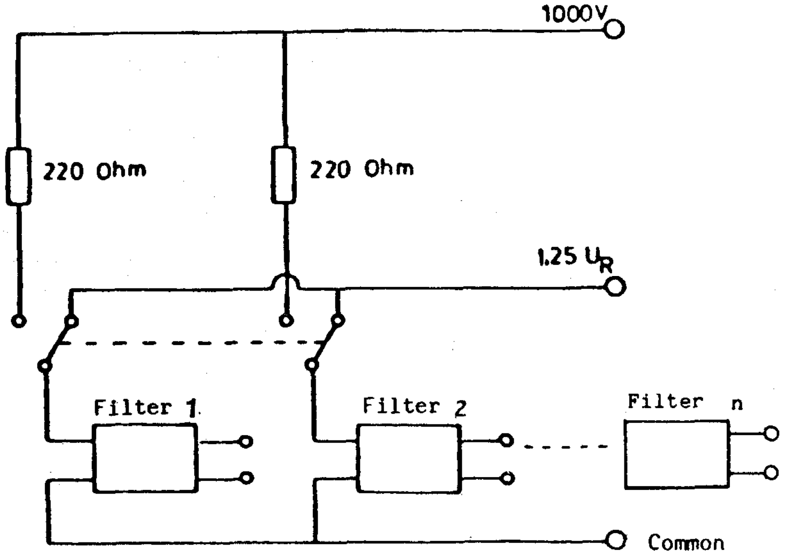


Fig. 1 Filters with X - capacitors

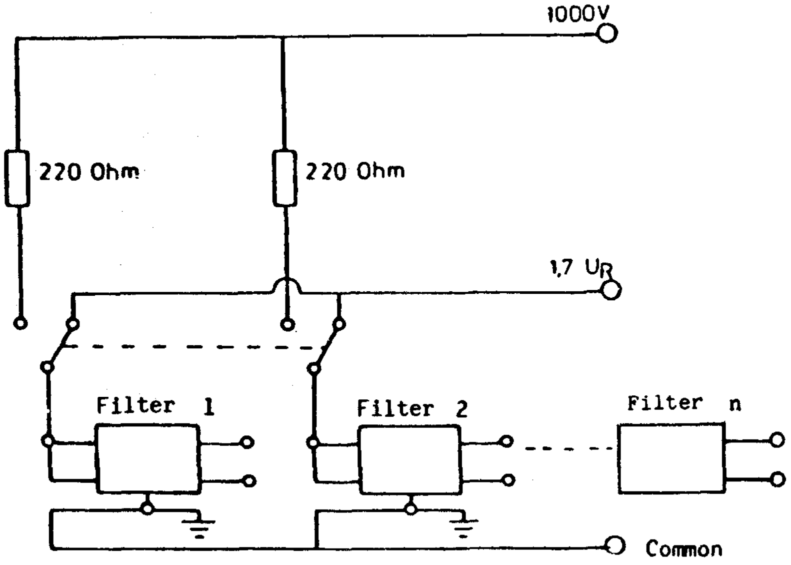
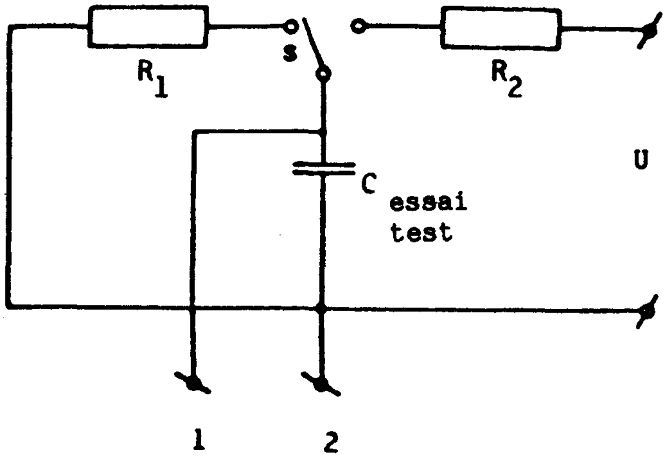


Fig. 2 Filters with Y - capacitors

Appendix B

Example of a suitable circuit for charge and discharge test

The test prescribed in Sub-clause 4.18 may be carried out with the following circuit:

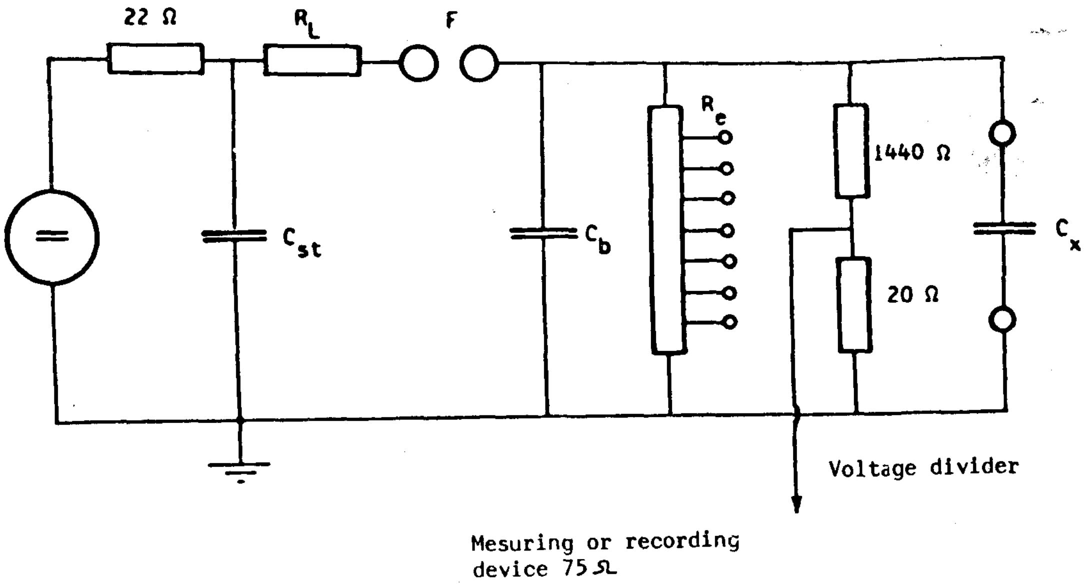


C_{test} = capacitors of filter under test.
R_1 = current limiting resistor (discharge).
R_2 = current limiting resistor (charge).
S = switching device.
U = test voltage (U_R for d.c. filters, $\sqrt{2}.U_R$ for a.c. filters).

1, 2 = terminations for oscilloscope connections to observe the maximum voltage gradients.

Appendix C

Example of a suitable circuit for the pulse test



R_L = charging resistor
3 x 7.5 Ω , 5A, very low inductance.
R_e = discharging resistor
0 ... 100 Ω , 10A, very low inductance.
C_{st} = charging capacitor
12 x 0.125 µF = 1.5 µF.
C_b = loading capacitor
8 x 2.96 µF in series = 0.37 µF.
C_x = filter capacitor(s) under test.

F = spark gap, sphere diameter
62.5 mm.

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